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GB 2131589 A US 4975814 A
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(54) Abstract Title
Flat panel lighting device

(57) A flat panel lighting device 1 comprises: a plate of transparent material 2, on which is applied an array of electroluminescent point sources 3 (such as LEDs, quantum wells or laser diodes); a second plate 7 which collimates light from the sources 3; an electrically and thermally conductive layer 4 (which may be transparent) connecting first electrodes of sources 3; and a second conductive layer (6, fig. 2) connecting second electrodes of sources 3. The collimating means 7 may be an array of microprojections with a reflective layer (8, fig.3), refractive microlenses, or a diffraction grating.

FIG.1

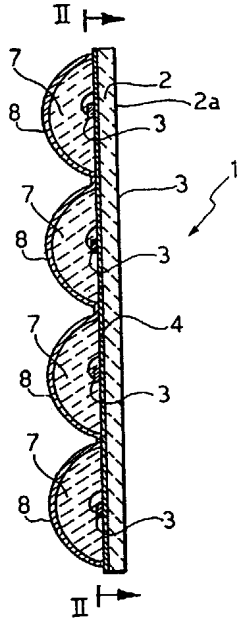

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FIG. 1

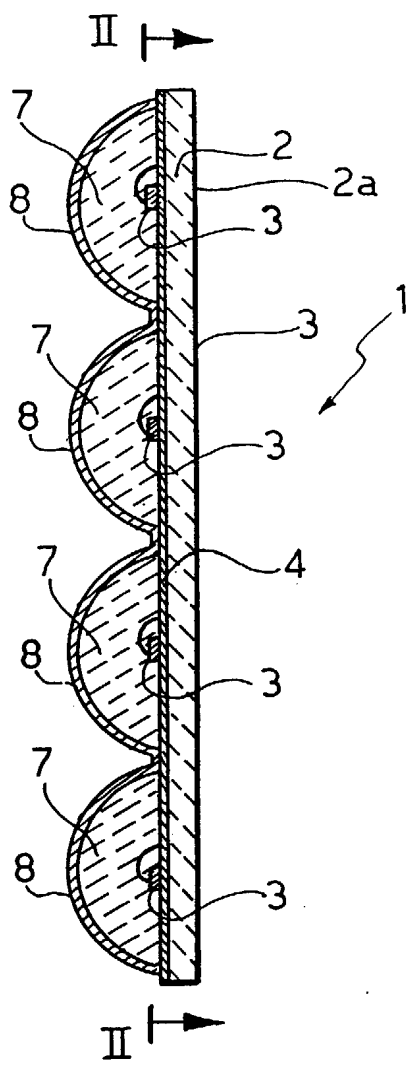


FIG. 2

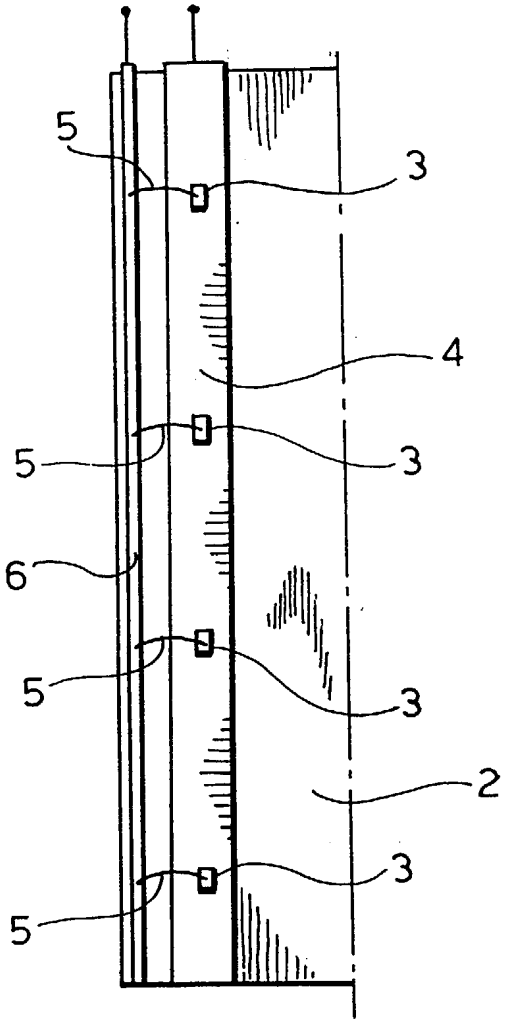


FIG. 3

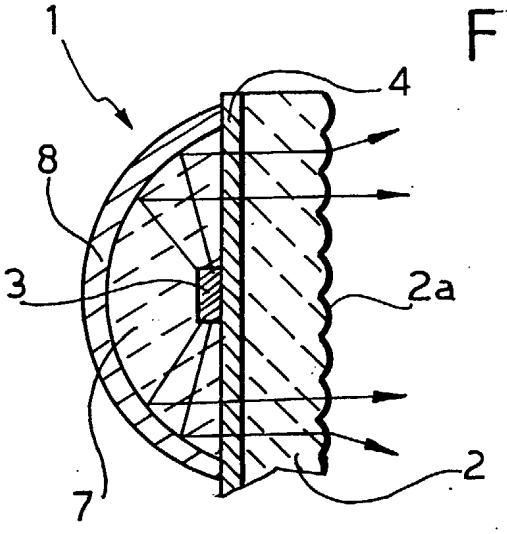


FIG. 4

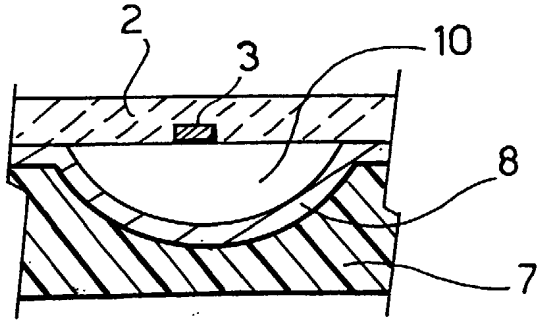


FIG. 5

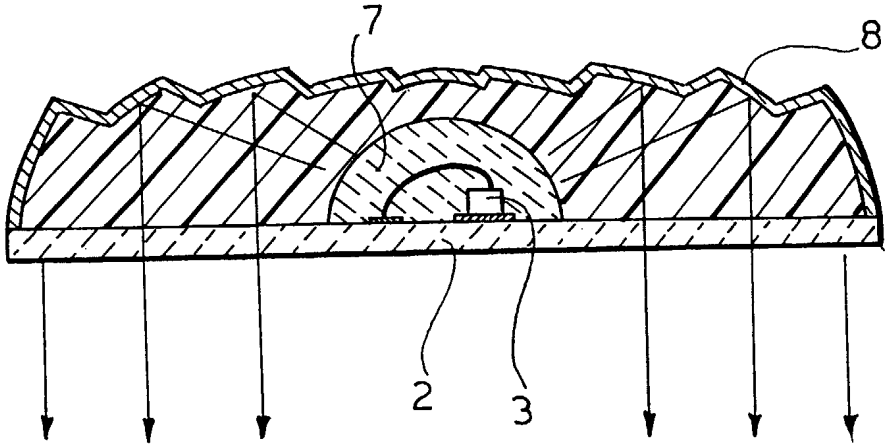


FIG. 5A

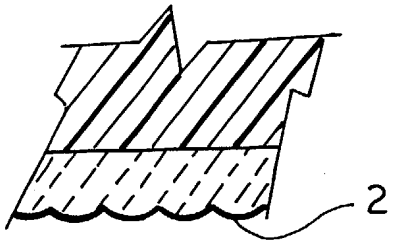


FIG. 6

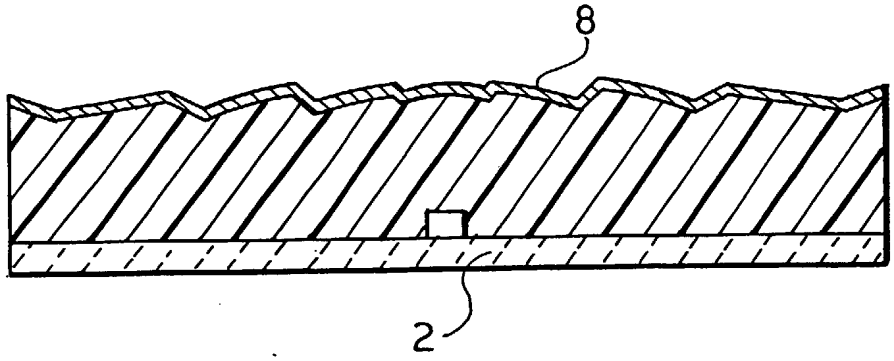
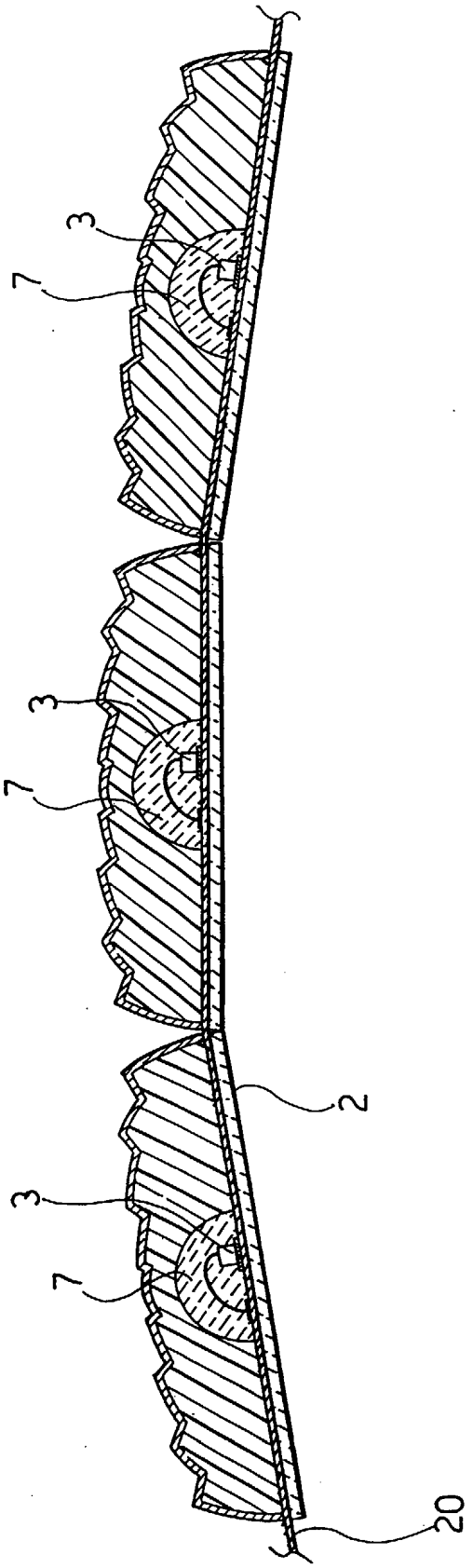


FIG. 7



A LIGHTING DEVICE

Background to the Invention

The present invention relates to a lighting device suitable for use as a headlight or lamp for motor vehicles.

In recent years, the Applicant has developed lighting devices that can be used, in particular, as headlights or lamps for motor vehicles which are characterized by extremely small dimensions and a high efficiency. European patent No. 766,115 in the name of the present applicant relates to a solution of this type, in which a vehicle headlight simply assumes the shape of a relatively thin plate of synthetic material to which one or more light sources are associated.

Recently there have also become available new technologies in the field of light sources, with particular regard to electroluminescent point sources, for instance of the type referred to as "white light-emitting diodes" or "white LEDs", of the so-called "quantum-well laser" type, "diode laser" type, or "quantum dot" type (see, for example, Hummel & Guenther, "Thin films for optical coatings", Vol. I, C.R.C. Press; Sugano & Koizumi, "Microcluster Physics", Springer; Arai, Mihama, Yamamoto & Sugano, "Mesoscopic materials and cluster", Kodansha Springer; Jacak, Hawrylak & Woys, "Quantum dots, Springer; W. Ekardt, "Metal cluster", Wiley; and B. Harrison, "Quantum wells, wires and dots", Wiley). These devices, however, have not yet been used to date in a fully satisfactory way, on account of their relatively low efficiency in terms of percentage of light energy produced that can be extracted outwards and in that, in addition, LEDs give rise to problems of heat dissipation.

Summary of the Invention

According to the present invention, a lighting device comprises:

a plate of transparent material;

an array of electroluminescent point sources applied on one face of the transparent plate and each having a pair of electrodes;

a layer of electrically conductive material set between the sources and said first face of the transparent plate, for connection to ground of a first electrode of each

source, said layer of conductive material being moreover designed to dissipate by conduction at least part of the heat generated by the sources;

a second conductive layer applied on the first face of the transparent plate and insulated from the first layer, said second conductive layer being connected in parallel to the electrodes of the sources opposite to those connected to the first layer; and,

a second plate set on the side of the sources opposite to the first plate, which defines means for collimating the light rays emitted by the source.

In a preferred embodiment of the invention, the collimation means consist of an array of reflecting microprojections, each of which is associated to a point light source. Preferably, the second plate is a moulded plate of plastic material having the aforesaid microprojections, which are provided with a reflective coating and have a paraboloidal profile or a profile of any other simple or complex geometrical shape, or even a segmented profile.

The conductive layers are connected to the electrodes of the sources in the form of chips using technologies of a wire-bonding type. The said conductive layers can be made, for example, of metal in order to obtain also good heat dissipation characteristics.

Brief Description of the Drawings

Examples of the present invention will now be described in detail with reference to the accompanying drawings, in which:

Figure 1 is a schematic sectional view of a preferred embodiment of the device according to the present invention;

Figure 2 is a sectional view along the plane indicated by the line II-II of Figure 1;

Figure 3 illustrates, on an enlarged scale, a detail of Figure 1;

Figure 4 illustrates a variant of Figure 3; and,

Figures 5, 5A, 6, and 7 illustrate two further variants.

Detailed Description

With reference to Figure 1, the number 1 designates, as a whole, a lighting device which may be used, for example, as a headlight of a motor vehicle. The device 1

basically has the shape of a relatively thin plate. It comprises a first plate 2, of transparent material, for example glass or a synthetic material, such as PET, PMMA, APEC, or LEXAN. In the latter case, the plate 2 may also be made having a certain degree of flexibility so that it can be mounted on the bodywork of a motor vehicle, adapting to the curvature of the bodywork. The plate 2 has a face 2a which faces outwards, and an opposite face 2B on which there is applied an array of electroluminescent point sources 3, for example made up of LED chips 3. The typical size of each LED 3 is in the region of 200-300 μm.

The plate 2 can have a thickness of between 1 mm and 5 cm.

Each LED 3 has, in a way of itself known, a pair of power-supply electrodes. Between the LEDs 3 and the face 2b of the plate 2 is set a layer of electrically conductive material 4 (see also Figure 2), for example aluminium or silver, which also has the function of dissipating at least part of the heat generated by the sources 3. Alternatively, it is possible to use a transparent conductive material, such as indium tin oxide (ITO). The opposite electrodes of the LEDs 3 are connected in parallel by means of links 5 to a second conductive layer 6, which is also applied on the surface of the plate 2.

On the side of the sources 3 that is opposite to the plate 2 is set a second plate 7, for example made of moulded plastic material, provided with means for collimation of the light rays emitted by the sources 3, the said means, in the example illustrated, taking the form of an array of microprojections 7, each of which is associated to a source 3 and is provided with a reflective coating 8. The microprojections 7 can have a paraboloidal profile or any other simple or complex geometrical profile, or even a segmented profile. As may be seen in Figure 3, the light rays emitted by each source 3 are directed towards the reflecting surface 8, which bounces them back outwards in a collimated beam or with a pre-determined convergence. According to a further characteristic, the outer surface 2a of the plate 2 can have an array of diffractive or refractive microprojections 9 to obtain at output a light beam having the desired characteristics.

Preferably, the plate 7 is made of the same transparent plastic material as the plate 2 or has an index of refraction equal to that of the plate 2.

Figure 4 illustrates, instead, a variant in which the plate 7 has a plurality of concave lenses, one for each light source, with a reflective coating on the surface. The plates 2 and 7 are set side by side or are bonded together by means of an adhesive so as to leave a gap 10 between the sources 3 and the plate 7. If the device is produced in a vacuum or in an inert atmosphere, this condition is preserved in the gap 10.

Thanks to the characteristics described above, the lighting device according to the invention is characterized by extremely small dimensions which render its use for making headlights or lamps for motor vehicles extremely interesting. In addition, the device according to the invention presents a high efficiency thanks to the possibility of directing outwards one prevalent part of the light produced by the electroluminescent point sources. At the same time, the problem of dissipation of the heat generated by said sources is solved thanks to the pre-arrangement of the conductive layers connected to the electrodes of the sources.

The present invention may be implemented as an electronic card for control of the chip, LED, quantum-well, quantum-dot, or SMD sources, using photolithographic and LIGA technologies. A thin film of glass, PET, PMMA, LEXAN, or polycarbonate can be used as sub-layer for deposition of the part produced using photolithography or electrodeposition of conductive material or ITO. Using the same technology it is possible to make chips of conductive metal for the additional purpose of dissipating the heat generated by the source. On bases of this sort it is possible to solder the aforesaid components, using standard die-bonding techniques (with conductive epoxy resins) and wire-bonding techniques (ultrasound)

The micro-optics for a device of this kind can be obtained also by vacuum moulding according to what is illustrated in Figure 5 (Figure 5A illustrates a detail of Figure 5 at an enlarged scale).

In an alternative arrangement, the sources referred to above can be embedded (by injection moulding) either in the plastic material or in the epoxy material, already

referred to, which constitutes the micro-optics, and can be supplied directly by means of simple wires of variable section, which are also embedded in the plastic material, as illustrated in Figure 6.

The individual unit corresponding to each individual source can be connected to other similar cells by means of sheaths of thin plastic material (MYLAR) 20 in order to make an extended headlight or lamp which is flexible at the joints, according to what is illustrated in Figure 7.

CLAIMS

1. A lighting device, in particular a headlight or lamp for motor vehicles, comprising:
a plate of transparent material;
an array of electroluminescent point sources, applied on one face of the transparent plate and each source having a pair of electrodes;
a first layer of transparent electrically conductive material set between the sources and said first face of the transparent plate, for connection to ground of a first electrode of each source said layer being moreover designed to dissipate by conduction at least part of the heat generated by the sources;
a second conductive layer applied on the first face of the transparent plate and insulated from the first layer, said second conductive layer being connected in parallel to the second electrodes of the aforesaid sources; and,
a second plate set on the side of the sources opposite to the first plate which defines means for collimating the light rays emitted by the sources.

2. A lighting device according to claim 1, in which said collimation means comprise an array of reflecting microprojections, each of which is associated to a light source and each of which is provided with a reflective coating.

3. A lighting device according to claim 1 or 2, in which the second plate is a moulded plate of plastic material with reflecting microprojections, each of which has a paraboloidal profile or a profile of any other simple or complex geometrical shape, or even a segmented profile.

4. A lighting device according to claim 2 or 3, in which the reflecting microprojections are made of a plastic material which is the same as that of the plate of transparent material.

5. A lighting device according to any preceding claim, in which the conductive layers are made of aluminium or silver.

6. A lighting device according to any preceding claim, in which the second face of said first plate has an array of diffractive or refractive microlenses, or a diffraction grating.

7. A lighting device according to any preceding claim, in which the second plate has a plurality of concave surfaces with reflective coating.

8. A lighting device according to any preceding claim, in which the electroluminescent point sources are chosen from a group consisting of LED sources, quantum-well laser sources, laser-diode sources, and quantum-dot sources.

9. A lighting device according to any preceding claim, in which the electroluminescent point sources are SMD type devices.

10. A lighting device substantially as shown in and/or described with reference to any of Figures 1 to 7 of the accompanying drawings.

Application No: GB 0117405.1
Claims searched: 1-10

Examiner: Peter Keefe
Date of search: 12 November 2001

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.S): F4R (RCAA, RCC, RFN, RFM, RL)

Int Cl (Ed.7): F21K (7/00), F21V (5/00, 7/00, 13/04, 29/00), H05B (33/00)

Other: Online: WPI, EPODOC, PAJ

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB2131589 A	INTEGRATED SYSTEMS fig. 15, p3 col.1 lines 8-15	1, 2 at least
X	US 4975814 A	SCHAIRER whole document	1, 2, 3, 4, 7, 8
X	WPI abstract 1989-192827 & WO 8905524 (IWASAKI)		1, 2 at least

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.